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The Influence of Basketball on the Asymmetry in the Use of Limbs

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A B S T R A C T

The purpose of this study was to determine how basketball affects the uneven use of the limbs in relation to non-basketball population. Participants were compared by multiple motoric and situational tests, and for each participant tested the relationship between all limbs, both upper and lower. Before the motoric and situational tests participants completed a questionnaire on preference in limb use in everyday life and during sports activities. Participants belong to two groups, one group of young players with the rank of at least four years experience in basketball training, while the second group consisted of members of the healthy school population, but with no experience in the continuous training of basketball. The study tested the explosive power of the lower and upper limbs, and the reaction time and agility in the lower limbs. Statistical analysis of results showed significant differences in certain tests between groups and within groups, both among the upper and lower extremities. It can be concluded that basketball has positive influence on the development of the tested variables, while the level of asymmetry at basketball players is less than the level of asymmetry in the non-basketball population.

Key words: *Asymmetry, Basketball, Preferred Limbs, Non-Preferred Limbs.*

Introduction

Uneven use of the limb was present as the world is divided conditionally speaking into right and left. With the evolution of the sport as a social phenomenon and in striving to achieve the best results there has been interest in the exploration of uneven use of the limbs in the sport, while in the past, this problem was investigated in the general population and is usually referred to the upper extremities.

In the mid 20th the concept of lateral dominance was defined by Harris[1], that the lateral dominance is bigger ability of one body part over another to perform some motor tasks. The reasons that lead to the occurrence of lateral dominance lies in the phenomenon of CNS to one side of the brain play a greater role in specific functions[2]. Increasing interest has developed a number of theoretical discussions about the causes and reasons of the lateralization[3,4,5,6,7,8,9], course for this article mentioned terms are informative, no intention to discuss about them.

In sport, the problem of inconsistent use of limbs starts to engage researchers in the field of medicine because of the frequent occurrence of anterior cruciate ligament injury ACL[10,11,12,13].

Some sports require constant improvement of one side of the body or one limb, for example sports with use of racket (tennis, squash, etc.), while in other sports, for example sports games (basketball, football, handball, volleyball, hockey etc.), require a greater degree of bimanual dexterity[14], or simultaneous use of the lower limbs, or all the limbs together. The level of players and their mastery of sports has an impact on the degree of bimanual dexterity[15]. Based on these assumptions, Stöckel and Weigelt[16] have carried out a research conducted w ith the video analysis of dribbling the ball, catching, passing and shooting, between preferred and non-preferred arm on a sample of 126 male basketball players (mean age 24.3 years). Basketball players have competed at various levels: (1) international level (n=43), (2) national professional level (n=20), (3) non-professional (n=43) and (4) juniors and amateurs (n = 20). The results showed a significant difference in use between dominant and non-dominant hand and the level of competition in which players participate ($r=0.496$, $p <.001$). Specifically it was found that the use of non-preffered hand increases as the level at which the athletes compete. At junior and recreational groups the percentage of non-preferred arm use was 10.3%, with 17.4% of non-professional players, the players of the national professional level of 31.2% and the players who compete at international level 26.1%. An interesting finding of this study is that the various technical elements that were studied (dribbling, trapping, passing, kicking, etc.), occurring in almost the same proportion as in the previously mentioned data.

Dauty and associates[17] have dealt with the identification of mechanical consequence of Jumper's knee injury in elite basketball players. The study was conducted on 15 basketball players with a history of Jumper's knee injury and a control group of 42 subjects without history of mentioned injury. Subjects were tested using a dynamometer and it was found the basketball related to asymmetry between the knee extensor muscle force was at a level of about 10%. An interesting fact in this study is that one in 7 patients in the control group has an asymmetry of about 10%, although none of them had a history of injuries.

Schiltz et al.[18] conducted a study examined the imbalances in an explosive force in professional basketball players and compared junior basketball players with the controls that are not actively involved in basketball. The study included 15 professional basketball players, 10 junior basketball players and 20 healthy men. Research has shown that the asymmetry occurs and to the professional basketball and is 12% and to the jumps in depth with a height of 20 cm, an asymmetry arises in favor of

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the dominant limb. There was also a difference in the height of the jump on one foot and it is a significant difference was also with professional players and it was 10.5%, while the juniors and the control group no significant difference.

Čvorović, Berić & Kocić[19,20,21] examined the asymmetry of the dominant and non-dominant limbs in the expression of muscular force, explosive strength and frequency of movement in basketball players of the younger age groups. They came to the conclusion that a significant asymmetry occurs in explosive strength of upper extremities and in the frequency of movement occurs with the upper and lower extremities and to the benefit of the dominant limb.

The literature often use the terms preferred leg, the preferred arm, preferred and non- preferred leg and arm, some authors the real disparities in relation to the concept of dominant non-dominant leg or arm, in this research these concepts will be treated as synonyms, as the case in most studies of this or similar type.

The aim of this study was to determine differences in the use of limbs as among the participants, and among the groups to which they belong, and thereby obtain information on how basketball affects the uneven use of the limbs compared to participants who are not engaged in active basketball training.

Materials and Metods

Participants

Participants in this study were members of a healthy male population aged 15 years, divided into two groups: first group consists of 15 players from the Basketball Club Flash from Belgrade (M_{age}=15±0.5 years, M_{BW}=71.73±9.17kg, M_{BH}=182.87 ±6.71cm), while the second group consists of 15 members of the healthy school population, but without a history of serious basketball training, from Elementary School Ivo Andric from Belgrade (M_{age}=15±0.5 years, M_{BW}=74.93±15.01kg, M_{BH}= 177.67±7.89cm).

Variables and Testing Procedures

Prior to testing participants completed a questionnaire on preference in the use of limbs. The questionnaire consists of six questions, three questions relating to the arms, and three on the legs, a limb that is mentioned in at least two options is the preferred or dominant limb. Questions were related to writing, shooting, and passing for the hands, and kicking, step on the stair and a take-off for of the legs. The questionnaire in research was taken from Čvorović[21], and it is only informative type in order to determine the subjective answer of preference in use of limbs in daily life, and certain sports activities.

Tested variables from the anthropometry are body height (BH), body weight (BW) and height of the reach of the extended arm above head (AR).

Motoric skills and variables that were tested are explosive strength of leg extensors, explosive strength of arm extensors, agility and reaction time to light signals.

Explosive leg extensor strength was measured with two tests. One test included in the horizontal jump with each leg separately, and the second test included the vertical jump after a running start with take-off from one foot, of course, was carried out for both legs separately. For the horizontal component of the explosive leg extensor strength (HJD - horizontal jump dominant and HJN - horizontal jump non-dominant) was used Hop for Distance Test[22]. The subjects stood on the test leg and then hopped as far as possible and landed on the same leg. Free leg swing was allowed. The hands were placed behind the back. The subjects were instructed to perform a controlled, balanced landing and to keep the landing foot in place (i.e. no extra hops were allowed) until (2–3s) the test leader had registered the landing position. Failure to do so resulted in a disqualified hop. Participant performed a jump with one leg and then with the other when it is ready, the rest interval between next two jumps is at least 2 minutes. The distance was measured in centimetres from the toe at the push-off to the heel where the subject landed. The vertical component of the explosive leg extensor (VJD - vertical jump dominant and VJN - vertical jump non-dominant) strength was measured with a Vertec Jump Testing System after run-up jump from single leg take-off[23], with the difference that the vertical jump is not measured after a certain number of steps, but the running start was with the three point line (6.75 m). Measured is the difference between the reach of the extended arm and reach after the jump. Subject conducted three jumps each leg separately, and recorded the best results achieved for each leg separately. Participant performed a jump with one leg and then with the other when it is ready, the rest interval between next two jumps is at least 2 minutes. The precision of measurement is 1 cm.

Arm extensor explosive strength (TBD - throwing the ball dominant and TBN - throwing the ball non-dominant) is measured by the modified Throwing Gate Test[24], with a platform for testing Newtest Powertimer 300 a portable system for field tests of Finland production. System consists of rubber mat with sensors, photocells set, the console to connect to the transmission computer that has installed software to track test results on the monitor. Difference from original Throwing Gate Test is that participants toss medicine ball with one hand at the level of the shoulders, not with two hands above his head. The subject stands in a parallel stance 1 m away from the first set of photocells, that are placed on the supports vertically one above the other to create an infrared curtain. From that position participants throwing a medicine ball a weight of 1 kg with one hand in the level of the shoulders and without moving the body and feet. After ejection the ball need to pass through the infrared curtain and hit the mat with sensors that hung on the wall at a distance 2 m from the curtain. The measurement started when the ball cut the beam from the infrared curtains, and ends when it hit the mat with sensors. Two results were obtained in the measurements, the flight time, expressed in milliseconds (ms) and speed of the ball in meters per second (m/s). This study analyzed data related to the speed. Subjects were allowed to do three attempts for each hand, and recorded the best results achieved for each hand separately. Participant performed a throwing with one hand and then with the other when it is ready, the rest interval between next two throwing is at least 2 minutes.

Agility (AGD - agility dominant, and AGN - agility non-dominant) was measured using the 505 Test on platform with Newtest Powertimer 300. The subject was on the start line on the track length of 15 m, the end of the path was line twist. Photocell is located 10 m from the starting line. Participants run from to the starting line and accelerates as possible, run by a photocell and cross the turning line where turn around with left or right leg and running quickly is possible by photocell. The movement was tested with three attempts of changing direction with dominant as well as with non-dominant leg, and recorded the best results achieved for each leg separately, precision of measurement is one 1 ms.

Reaction time (RTD – reaction time dominant, and RTN – reaction time non- dominant) was measured also using the platform for testing Newtest Powertimer 300 and with Take-Off Reaction Time Test. This test is performed by the participant on rubber mat with sensors versus the command console, which is only two meters from mat on which the participant is, on the left and right at a distance of 5m of the mat where the participant is located two photocells. The subject is facing towards the control panel with slightly bent knees and hands on the hips in the ready position, a command console comes with a buzzer and light for the start signal for the direction of movement. Following this signal, the participant raised leg toward the direction of movement, and the other leg pushes up quickly and set up motion in a given direction is determined by measuring the response time of giving the signal to start the movement and speed of a given signal to pass through the photocell. The console provides random signals for both directions of movement 3-5 times for each direction, and recorded the best results achieved for each direction separately and the difference between left and right sides. For the purposes of this study are treated only data related to the response time to a given light signal. Rest interval between attempts is one minute. The precision of measurement is 1 ms.

TABLE 1
DESCRIPTIVE STATISTICS FOR ALL TESTED VARIABLES

	Non-Basketball Group		Basketball Group	
VARIABLES	Mean	Std. Dev.	Mean	Std. Dev.
BW(kg)	74.93	15.01	71.73	9.17
BH(cm)	177.67	7.88	182.86	6.71
AR(cm)	233.27	10.19	241.33	9.41
VJD(cm)	32.87	9.32	56.33	5.65
VJN(cm)	42.06	7.54	62.13	6.21
HJD(cm)	138.06	17.20	163.60	10.81
HJN(cm)	137.53	15.46	162.33	9.20
AGD(ms)	3216.13	301.52	2525.20	127.98
AGN(ms)	3225.40	388.66	2515.06	123.11
RTD(ms)	810.20	91.19	780.80	71.99
RTN(ms)	822.06	91.14	749.46	65.73
TBD(m/s)	7.89	0.50	8.72	0.89
TBN(m/s)	6.67	0.38	8.14	0.84

Explanation of abbreviations for Table 1: BW - body weight, BH-body height, AR-arm reach, VJD – vertical jump dominant, VJN – vertical jump nondominant, HJD – horizontal jump dominant, HJN – horizontal jump non-dominant, AGD- agillity dominant, AGD- agillity non-dominant, RTD - reaction time dominant, RTD - reaction time non-dominant, TBD – throwing the ball dominant, TBN – throwing the ball non-dominant.

Design and Analysis

The statistical procedures that are used in the field of descriptive statistics were treated with variables related to body height and body weight and for all motoric variables. The difference between the extremities in motoric tests was treated with the coefficient of asymmetry, which is expressed in per- centage and is calculated by the formula AS=D-ND/Dx10025 where is: AS - asymmetry coefficient, D - dominant side; ND - non-dominant side. Significant results are considered to be above 5%. The difference between groups and within the subjects was tested by mixed design ANOVA with dominant and non- dominant measurements as repeated factors (*dnmf – dominant and non-dominant measurements factor*) for significance level at $p<0.05$. Statistical analysis was carried out using SPSS 19 software forWindows.

Results

Results of the questionnaire in a group of basketball players showed that the number of participants with dominant or preferred right hand is 15 or 100%. As for the legs 10 participants stated right leg as the preferred or 66.67%, while the left leg as a dominant participant listed in 5 or 33.33%.

In the group of non-basketball as the dominant right hand led the 14 participants or 93.33%, while one participant stated his left hand as dominant, or 6.67%. The dominant right leg led 14 participants or 93.33%, while the dominant left leg was observed in one participant or 6.67%.

Results related to the asymmetry coefficient for non-basketball group (NVJ/AS), showed that are statistically significant NVJ / AS =-26.63%, and values are negative, which means that the non-dominant leg is stronger than the dominant one in this test. For the same test within a group of basketball players asymmetry coefficient (BVJ/AS), results showed that are also statistically significant BVJ/AS=-10.37%, and also values are with a negative sign indicating that the non-dominant limb exhibited greater strength.

For horizontal component of explosive leg strength in non-basketball group coefficient of asymmetry (NHJ/AS), results shown that difference between limbs was statistically insignificant NHJ/AS=0.05%. For the same variable, but within a group of basketball players asymmetry coefficient (BHJ/AS), results was also statistically insignificant BHJ/AS=0.67%.

The variable explosive strength of arm extensor in the group of non-basketball for results of coefficient of asymmetry (NTB/AS), showed a statistically significant difference between the upper limbs and to the benefit of the dominant limb NTB/AS=15.36%. For the same variable in a basketball group coefficient of asymmetry (BTB/AS), results also showed a statistically significant difference between the upper limbs and to the benefit of the dominant limb BTB/AS=6.42%.

Results of the coefficient of asymmetry within the group of non-basketball players related to agility (NAG/AS), showed statistically insignificant difference between the limbs of the variables NAG/AS=-0.24%. Also in the group of basketball players were no significant differences between the extremities for agillity variables, which is confirmed by the results of coefficient of asymmetry BAG/AS=0.35%.

The results for variable reaction time in non-basketball group for coefficient of asymmetry (NRT/AS), have shown that was not statistically significant difference between the extremities in this group NRT/AC=-1.90%. For the same variable in the group of basketball players coefficient of asymmetry (BRT/AS), also not determined statistically significant difference between the extremities BRT/AS=3.19%.

Results obtained by mixed design ANOVA showed significant differences within subjects for variables related to vertical jump abillity (VJD and VJN), $F=36.468$, $p<0.05$, and between groups of subjects, $F=85.382$, $p<0.05$. For horizontal jump variables (HJD and HJN), results showed there were no significant differences within subjects, $F=0.496$, $p>0.05$, for the same variables but between groups results showed significant differences, $F=28.030$, $p<0.05$.

Results for mixed design ANOVA showed for agillity variables (AGD and AGN), there were no significant differences within subjects, $F=0.000$, $p>0.05$, for the same variables but between groups results showed significant differences, $F=60.126$, $p<0.05$.

Results obtained by mixed design ANOVA showed significant differences within subjects for variables related to explosive strength of uper limbs (TBD and TBN), $F=82.398$, $p<0.05$, and also between groups of subjects results showed significant differences, $F=24.327$, $p<0.05$.

For reaction time variables (RTD and RTN), results from mixed design ANOVA showed there were no significant differences within subjects, $F=0.360$, $p>0.05$, for the same variables but between groups results showed significant differences, $F=4.281$, $p<0.05$.

Discusion

The main objective of this study was to determine the presence of asymmetry in the limbs of young basketball players as compared with peers who are not actively involved in basketball training and belong mainly to sedentary population. From results of statistical analysis are isolated two variables that are statistically different within the groups they belong to and among groups, and these variables are related to the explosive strenght of the extensors of the hand and the explosive strenght of leg extensors with pronounced vertical component.

Results of the research for upper limbs asymmetry are in agreement with several studies conducted so far[26,19]. Certainly the results and any agreement should be interpreted with caution, because in this area is insufficient number of research to make a set of variables and testing standards, and research methodology and measurement instruments differ.

In the lower extremity the results are quite different from each other, because they are tested with two tests, one with a pronounced horizontal component, but without the arm swing and another with a pronounced vertical component, but with arm swing during the jump, where statistically significant differences to the benefit of the non-dominant lower limb. In basketball this movement is one of the basic technical movements in attack and is directly related to achievement points with very small distance from the rim and usually ends with the dominant hand, and take-off foot is non-dominant, and that's probably the reason for the asymmetry determined. The results obtained in this test, mainly referring to the basketball group are in agreement with the results of research from Young, Wilson & Byrne[22], with the difference that in above mentioned study measured only the vertical jumping ability of the dominant side of the body. The results for the horizontal jumping ability, where there were no significant differences between the lower limbs is consistent with the research from Čvorović, Berić & Kocić[19,21], which also showed no statistically significant differences between the lower limbs.

As for agility were no statistically significant differences among the groups tested in the lower limbs, while there is a difference between groups and statistically significant in favor of basketball players. Results obtained by testing with a 505 test for basketball players group are fairly consistent with the results released by Gore[27], course in terms of asymmetry, while the results of his research are little better, because these are the players of senior age, and national levels.

As for the reaction time results are tentatively quite high compared to say a sprinter and reaction time related to the upper limbs, but it should be noted that the movement in the test which was performed quite differently from the aforementioned and reason for this probably lies in the Hick's Law, which states that the amount of time it takes to prepare a response is dependant upon the number of stimulus-response (SR) alternatives that are present[28] , but they are quite consistent with the results of research from Pradas, Carrasco & Izaguerri[29] because they use the same testing procedure with Newtest, with the difference that there were no statistically significant differences within the groups in terms of reaction time.

Conclusion

In conclusion of this study can be stated that basketball as a sport positively influence on the variables that were tested in comparison to a healthy school population, and more importantly what results from this study is the fact that basketball have a positive transfer to reduce the level of asymmetry between the limbs. The reason for this is probably the nature of competitive activity and the technical demands of the sport which requires solving the bimanual movement tasks, as the same may be said for the lower limbs. Future research should include more participants of all ages and levels and to examine some other variables, and it would certainly be interesting to conduct a training program aimed at reducing the level of asymmetry that would result in more complete player and would reduce the possibility of injuries that occur as a result of functional imbalances between limbs.

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UTICAJ KOŠARKE NA NEUJEDNAČENU UPOTREBU EKSTREMITETA

S A Ž E T A K

Svrha sprovedenog istraživanja je bila da se utvrdi kako košarka utiče na neujednačenu upotrebu ekstremiteta u odnosu na ispitanike koji se ne bave košarkom. Učesnici su upoređivani kroz više motoričkih i situacionih testova i kod svih učesnika su testirani međusobni odnosi kod ekstremiteta, kako kod gornjih tako i kod donjih. Prije sprovodjenja testiranja učesnici su popunjavali upitnik koji se odnosi na preferiranost u upotrebi ekstremiteta u svakodnevnom životu i u okviru sportskih aktivnosti. Učesnici su svrstani u dvije grupe, jednu su činili mladi košarkaši sa najmanje četiri godine kontinuiranog košarkaškog treninga, dok su drugu grupu sačinjavali pripadnici zdrave školske populacije, ali bez iskustva u kontinuiranom košarkaškom treningu. Testovi koji su korišćeni u okviru istraživanje odnose se na eksplozivnu snagu gornjih i donjih ekstremiteta i na agilnost i vrijeme reakcije kod donjih ekstremiteta. Rezultati statističke analize dobijenih podataka su pokazali značajne razlike u pojedinim testovima, kako medju ispitanicima, tako i među grupama i to i kod gornjih i kod donjih ekstremiteta. U zaključku je navedeno da košarka kao specifična sportska aktivnost ima pozitivan uticaj na sve testirane motoričke sposobnosti, a što se tiče nivoa asimetrije među ekstremitetima utvrđeno je da je niži kod košarkaša nego kod vršnjaka koji se ne bave košarkom.

Ključne riječi: Asimetrija, košarka, preferirani ekstremiteti, nepreferirani ekstremiteti.